

## DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA) TECHNIQUE APPLICABLE FOR COST REDUCTION - A REVIEW

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### ABSTRACT

*In the manufacturing process, a design is the first step where most of the important decisions are made which affect the final cost of the product. The main emphasis is given to obtain an optimum design solution for an existing product. It has been already proven fact that a large percentage of the product cost is due to the complex manufacturing and assembly process. DFMA can be used as an early cost estimation technique. And there are no boundaries to the application of the DFMA principles. One can use DFMA throughout any type of organization/enterprise/industry. It can also be used in case of multidisciplinary tasks, supply chain management, activities based on manufacturing and assembly or the architectural design choices of any product development and manufacturing. This paper reviews on Design for Manufacturing and Assembly (DFMA) principles and its applications for early cost estimation and reduction techniques.*

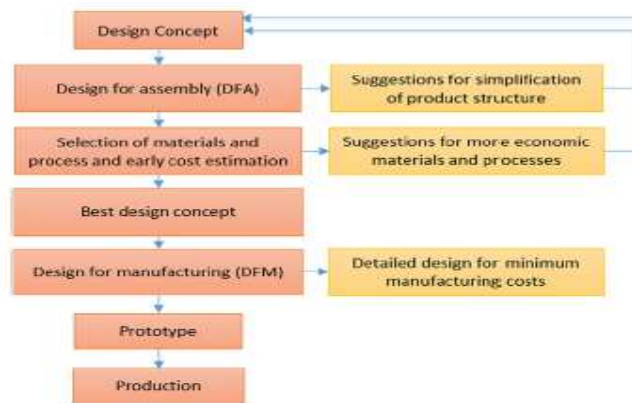
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### INTRODUCTION

The traditional product design approach is one-sided approach, where design engineers and production engineers used to work diversely. Designers used to design a product and production engineers used to manufacture it. There was a communication gap between Design Engineer and Production Engineer, this approach was named as an 'Over the wall approach'. A traditional design project generally consists of two needs one is the identification of the customer's needs and second is its necessity as an input. Another most important reason to consider manufacturing and assembly early in the design process is that it consists of over 70% of the total cost is determined during design.[1] DFMA assists to reduce these excessive costs by considering manufacturing and assembly process at the initial stage. As a result of this approach, manufacturer can also get rid of a lot of redundant parts or subassemblies and choose the most efficient and reliable manufacturing and assembly process, which results into the total reduction in part count and also the cost. The DFMA principles/software helps to estimate various factors in the product design which are responsible for Complex manufacturing and assembly process, Delay in product development and its Market time. To evaluate these factors an extensive research has been carried out and presented below.

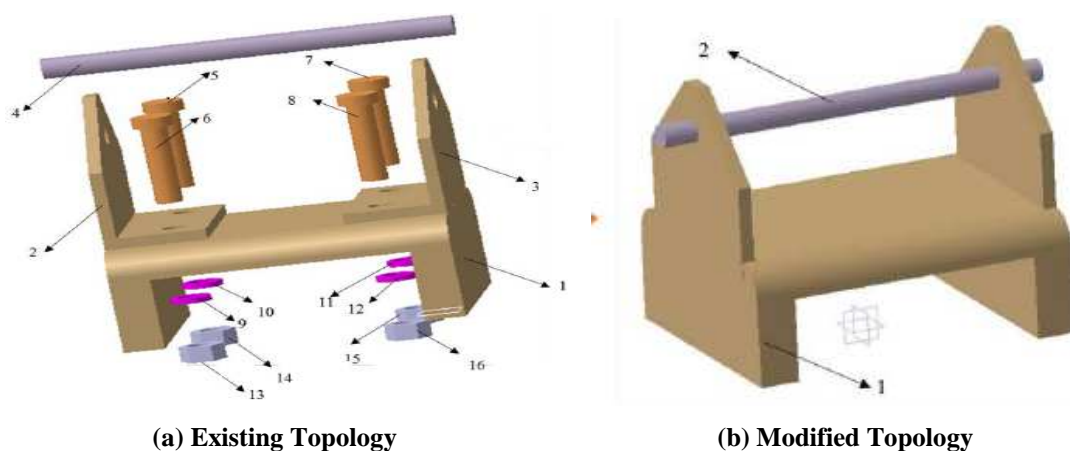


**Figure 1: Boothroyd and Dewhurst DFMA Procedure [1]**

## LITERATURE SURVEY

C. D. Naiju et al [2] conducted a study and analysis of a shopping cart design, manufacturing and cost estimation. This cart is widely used in supermarkets, departmental stores, and many more places; the first priority of this analysis was to reduce the part count of the cart and to reduce the cost. The CAD model of all the parts of the cart was analyzed by using DFMA software as well as Boothroyd Principles. Redesign of the product is manufactured by using a commercially available metallic weave instead of casting the parts. Redesign of some parts causes ease of assembly and elimination of some expensive processes which leads to the better and optimized product than the existing one. The observed reduction in assembly time was 3178.82S i.e. 3.89%. Price of the existing product was \$327 and the price of the redesigned product was \$314. The total reduction in the cost of the modified product is 3.9%. This might seem a small change but while manufacturing for mass production it causes a lot of difference and end up in a considerable profit margin. [2]

G Bala Murali et al [3] states that in the manufacturing process 30% of the total time is consumed in only assembly operation compared to all other operations. Hence they have implemented a novel method to the automation of the assembly sequence and that is a combination of AI (Artificial Intelligence) and DFA (Design for Assembly). This method reduces the number of parts i.e., it merges the parts which satisfies DFMA principles because of that manufacturing and assembly cost and its time gets reduced.



**Figure 2: Machine Frame Model [3]**

Boothroyd et al. [4] state that before the adoption of DFMA, design engineers would typically work irrespective of manufacturing and assembly process, the objective of DFMA is to reduce cost in the overall life of a product. There is a number of approaches available on how this can be achieved. Most notably, authors were a pioneer in formalizing such an approach. They provide criteria's upon which each part must be examined. And it is focused on part count reduction in increasing product assemblability. However; every manufacturing system will require the development of its own tailored tool. The authors concluded that no improvements in operation can make a plant fully competitive if the product design is defective. Design for Manufacture and Assembly can be the key to high productivity in all manufacturing industries.

Claudio Favia [5], discussed "A multi-objective design approach to include material, manufacturing and assembly costs in the early design phase." and states that Conceptual design is a crucial activity in the product development process. The design freedom must consider a trade-off analysis among several aspects such as assembly, manufacturing, and costs. To create feasible design options for multi-objective design approach is the main intension. The approach is based on the concept of the analysis of product modules and the theory of Multi -Criteria Decision Making (MCDM) approach. The main intension of this work is to define a multi-objective design approach which aims to have a comprehensive analysis of the manufacturing aspects (including assembly, materials, processes, costs and times).

H.Tasalloti et al [6] state that for the adoption of Concurrent Engineering (CE) in the design of welded structures, a new model is proposed that integrates the Design for Manufacturing and Assembly (DFMA) with Product Data Management (PDM) system. This product data management (PDM) system is integrated with DFMA as a database of welding processes, materials, consumables, standard and guidelines as well as for storing and tracking changes in weldment design [6] The proposed approach in this paper is also useful in coordination with CAD applications and manufacturers Product Data Management (PDM) software to increase the quality of a design of a weldment. And since this PDM it enhances the decision making as its use by designers require only minimum welding and metallurgy knowledge.

Zhenmin et.al[7]states that design for manufacturing and assembly (DFMA) in prefabricated building design, and it combines with the parametric design of Building Information Modeling(BIM) to develop the concept of DFMA oriented parametric design. Authors have also stated that how to create a prefabricated building information model for construction and its precast components information models for manufacturing, which have good manufacturability and assemblability so as to avoid the manufacture and assembly problems in later stages and improvement the one-time success rate of design. In comparison with the traditional manufacturing process, this newly developed model is more manufacturable and assemblable.

Wankhade Nitesh Prakash et al [8] have used DFMA to re-design a ball valve fluid flow control valve and optimized its design to ensure a reduced number of parts, safety, and reliability. Early consideration of manufacturing issue also shortens product development time, minimize cost and ensure a smooth transition into production for a quick time to market. Therefore optimum design, low cost and good quality with quick delivery was the outcome of this research work. Total no of parts present in the existing design is 23 and after application of DFMA principles, the part count is 6. This results in cost reduction. Observed changes in assembly time are from 145 sec to 45 sec.i.e. 68% reduction.

Akshay Harlalkaa [9] suggests that significance of implementation of DFMA on an Indian consumer product (in-market food processor). DFMA is considered an effective cost reduction technique. While studying existing design author notices that there is a lot of opportunities where DFMA principles can be applied so that the cost of the product can be reduced. In accordance to DFMA principles Design objectives were proposed. As a result, there was a significant

improvement in Product Architecture, Assembly time & design Efficiency. This paper concludes that, by using DFMA principles an increase in DFA index is from 15.99 to 19.93 overall costs saving if 0.25 USD (INR 16.79) and reduction of 108.49 sec in total assembly time was achieved. [9]

Mohd Nazri [10] stated that the significance of the DFMA is to reduce the total part count. This analysis contributes to the reduction to the manufacturing cost, Assembly time and material hence author conducted an analysis of the water nozzle as a case study, and used Lucas-Hull methodology. The original design is reviewed, analyzed and redesigned. By the analysis, author concluded that redesigned assembly is consisting of fewer parts 13 to 8, and a total reduction in cost is almost 40%. This cost reduction will result into the profit margin.

As per the study of a literature survey of DFMA, few findings are stated below.

## FINDINGS OF THE LITERATURE SURVEY

- Researcher has applied DFMA principles/Software to the wide range of products such as Electronics appliances, Machine frames, Various Mechanical components and many more.
- DFMA provides a schematic approach to the analyze the proposed design, and it suggests the simpler and more reliable design.
- The important advantage of this method is that it reduces the parts or subassemblies and this contributes to the part count as well as cost reduction.
- DFMA tool encourages communication between design & production engineer. Design for Manufacturability has provided engineers with a systematic methodology to reduce development time, cut production cost, improve quality and reduce defects.

## CONCLUSIONS

This paper summarizes that Design for Manufacturing and Assembly (DFMA) tool is the key factor in cost reduction, ease of assembly, and in the reduction of total manufacturing & assembly time. By the application of DFMA, one can achieve 4 to 40% cost reduction. DFMA also focus on each and every individual process included in the manufacturing and assembly method. This is the systematic method to analyze the product manufacturing.

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